SMD Operations Procedures Manual

8.1.3.20 CRYOGENIC OPERATION OF CABLE TEST DEWAR #5

Text Pages 1 through 10

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8.1.3.20 Cryogenic Operation of Cable Test Dewar #5

1.0 Purpose and Scope

This procedure provides instruction on the following operations of the Cable Test Dewar #5.

- Pump & Purge Cable Test Dewar #5.
- Cooldown to 100 K for Cable Test Dewar #5.
- Cooldown to 4.5 K and 4.5 K Operation for Cable Test Dewar #5.
- Cooldown to 1.9 K and 1.9 K Operation for Cable Test Dewar #5.
- Warmup for Cable Test Dewar #5.

2.0 Responsibilities

Operator is responsible for the cryogenic operations associated with testing cable sample in Cable Test Dewar #5.

2.1 After cable sample is installed in the dewar and all cryogenic lines are connected, the operator is responsible for the pump & purge operation to make sure the system is clean and leak tight.

2.2 After pump & purge is completed, the operator is responsible for cooling the dewar including a magnet to 100 K using the liquid nitrogen heat exchanger. Typically, it takes twelve (12) hours to reach 110 K and overnight operation is required.

2.3 After Cable Test Dewar #5 reaches 110 K, the operator is responsible to cool the Cable Sample and Measuring Magnet to 4.5 K using liquid helium. Unlike other Test Dewars, Dewar 5 is capable of providing cooling at both 4.5 and 1.9 K. For 1.9 K operation, the operator shall follow the procedure given in 5.4. Throughout the test, the operator is responsible for maintaining proper liquid level in the dewar. Since Cable Test demands stable temperature, the operator shall control pressure accurately. Once in a while, the magnet quench. The stored energy is dumped to liquid helium and pressure rises in the dewar. The operator is responsible to cool the system back to the operating condition.

2.4 At the conclusion of the test, the operator is responsible for warming up the system to room temperature using helium flow through the electric heater.

3.0 Prerequisites

3.1 Operator shall be instructed by a supervisor or an authorized operator.

3.2 Instruction shall include the operation of vacuum pump, liquid nitrogen heat exchangers, 1000 gallon and 10,000 Liter liquid helium storage dewars and warmup heaters.

3.3 Instruction shall include the computer display page of the Cable Sample Test.

4.0 Precautions

4.1 Transfer liquid helium to Cable Test Dewar involves pressurizing the liquid storage dewar in use. The operator shall follow the operating procedure not to over pressure the liquid storage dewar.

5.0 Procedure

5.1 Pump & Purge Cable Test Dewar #5

5.1.1 Make sure the supply, return, gauge, air line and all five lines for the current leads are properly connected for Cable Test Dewar 5.

5.1.2 Make sure the insulating vacuum is established.

5.1.3 Make sure valves in the supply header

MOV300S - liquid helium supply,
MOV304S – warmup supply,
MOV305S – transfer line cooldown valve, and
MOV308S – 100 K cooldown supply
are closed.

5.1.4 Make sure valves in the return header

MOV302S – to SULLAIR compressor (subcool return),
MOV303S – to dirty gas bag,
MOV307S – to vacuum pump, and
AOV301S – to warm return
are closed.

5.1.5 Open top fill valve AOV312S and bottom fill valve SV311S. Open JT valve AOV313S from computer in the Cable Test Control Room.

5.1.6 Crack open vacuum pump valve MOV307S to pump on Dewar 5. For 1.9 K operation, also open MOV332 to pump on the suction line to 1.9 K vacuum pump (THIS LINE IS DISCONNECTED AT PRESENT). The vacuum pump is on all the time. Avoid over loading the vacuum pump.

5.1.7 After the pressure decreases somewhat, fully open MOV307S and MOV332 (for 1.9 K only).

5.1.8 The dewar pressure, as shown on PI360S, should reach –30" shortly.

5.1.9 When the pressure is less than 200 micron, on the vacuum gauge VI370S, close MOV307S and MOV332.

5.1.10 Open MOV302S (subcool) to fill Dewar 5 with clean helium.

5.1.11 When After the 1st pump down, leak check shall be performed for all connections on the top hat of Dewar 5.

5.1.11.1 Close MOV302S.
5.1.11.2 Open MOV304S (warmup) to fill Dewar 5 to 7 psi on PI360S.
5.1.11.3 Use Leak Teck to check all connections.

5.1.12 Repeat steps 4 through 8 three more times.

5.1.13 The pump and purge is completed and Dewar 5 is connected to low pressure clean helium thru MOV302S.

5.2 Cooldown to 100 K for Cable Test Dewar #5

5.2.1 Make sure Cable Test Dewar 5 has been properly pumped and purged.

5.2.2 Make sure valves in the supply header

MOV300S - liquid helium supply,
MOV304S – warmup supply,
MOV305S – transfer line cooldown valve, and

MOV308S – 100 K cooldown supply
are closed.

5.2.3 Make sure valves in the return header

MOV303S – to dirty gas bag,
MOV307S – to vacuum pump, and
AOV301S – to warm return
are closed.

5.2.4 Open liquid nitrogen supply valve AOV301N for the LN_2 heat exchanger.

NOTE: Check MOV222 & MOV223 warm helium supply are open.

5.2.5 Wait approximately twenty minutes until the vent line in the LN_2 heat exchanger becomes cold. This ensures liquid nitrogen in the heat exchanger.

5.2.6 Open AOV301S on low pressure return line.

5.2.7 Fully open MOV308S for the helium flow. Use the throttling valve in front of the flow meter for additional flow adjustment. The flow meters should be kept at 25 psi and 8 SCFM.

5.2.8 Watch temperature on the computer for Cable Tests. The temperature will decrease with time. It takes about 12 hours for the magnet assembly in Dewar 5 to reach 100 – 125 K.

5.2.9 Close 100 K cooldown valve MOV308S.

5.2.10 Close liquid nitrogen supply valve AOV301N.

5.3 Cooldown to 4.5K and 4.5 K Operation for Cable Test Dewar #5

5.3.1 After Dewar 5 is cooled to about 100 K, one can proceed 4.5 K cooldown.

5.3.2 Make sure valves in the supply header

MOV300S - liquid helium supply,
MOV304S – warmup supply,
MOV305S – transfer line cooldown valve, and
MOV308S – 100 K cooldown supply
are closed.

5.3.3 Make sure valves in the return header

MOV303S – to dirty gas bag,
MOV302S – to subcool return, and
MOV307S – to vacuum pump
are closed.

5.3.4 Set AOV301S, on low pressure return, to 18 psi and AUTO.

5.3.5 Select either Storage Dewar 1, 2 or 3 to provide liquid helium.

5.3.5.1 For SD 1 and PAT is running, close return valve HE34 slightly to increase pressure in SD 1 to 7 psi.

5.3.5.2 For SD 1 and PAT is not running, use warm helium to pressure SD 1 to 7 psi by opening H0245M and pressure regulator PR0261. Close HE34 all the way.

5.3.5.3 For SD 2 and HEUB is running, close return valve X1154M slightly to increase pressure in SD 2 to 7 psi.

5.3.5.4 For SD 2 and HEUB is not running, use warm helium to pressure SD 2 to 7 psi by opening H0279M and pressure regulator PR0296. Close X1154M all the way.

5.3.5.5 For SD 3 and HEUB is running, close return valve X581M slightly to increase pressure in SD 3 to 7 psi.

5.3.5.6 For SD 3 and HEUB is not running, use helium to pressure SD 3 to 7 psi by opening pressurizing valve H0334M (the red Hoke valve) and set the pressure regulator. Close X581M all the way.

5.3.6 To get ready for transfer liquid helium to Cable Test Dewar 5, open the helium supply valve on the storage dewar.

5.3.6.1 For Liquid SD 1, open AHE32 and H326M.

5.3.6.2 For Liquid SD 2, open X1220M and H329A.

5.3.6.3 For Liquid SD 3, open X580A and H329A.

5.3.7 Open MOV305S to cool the liquid helium line. When liquid air dripped from the line, close MOV305S.

5.3.8 Open liquid helium supply valve MOV300S to cool Cable Test Dewar 5.

5.3.9 Open fill valves AOV312S, SV311S, JT valve AOV313S and MOV310S (1.9 K heat exchanger vent).

5.3.9.1 Adjust storage dewar supply valve MOV300S to control the cooldown from 100 K to 4.5 K. Watch the return pressure and pump back.

5.3.9.2 Open valves for lead flow MOV321S, MOV322S, MOV323S, MOV324S and MOV325S.

5.3.10 On the cable test computer display page, observe temperature readings inside the dewar.

NOTE: It will take about one and half hours for the temperature inside dewar 5 reaches 4.5 K and liquid level in the lower gauge to occur.

5.3.11 Liquid levels in the upper gauges and in the 1.9 K heat exchanger will follow afterward.

5.3.12 Switch the controller of AOV312S to automatic for maintaining constant liquid level in the upper gauge.

5.3.12.1 Close AOV311S bottom fill. Dewar 5 is ready for 4.5 K test or 1.9 K pump down.

5.3.13 At the end of the 4.5 K or 1.9 K test, close liquid helium supply valve on the selected storage dewar.

5.3.13.1 Close liquid helium supply valve AOV312S.

5.3.13.2 Close valves for lead flow MOV321S, MOV322S, MOV323S, MOV324S and MOV325S.

5.3.14 Vent helium in the cold transfer line and close the cold helium supply valve on selected storage dewar and distribution line.

5.3.14.1 For Liquid SD 1, liquid helium supply valve MOV300S can be closed right away by opening HE37 to vent.

5.3.14.2 For Liquid SD 2 and SD 3, leave MOV300S open for 30 minutes before closing. Alternatively if storage dewar is not in use, MOV300S can be closed right away by opening H326M and HE37.

NOTE: In either case, the vent valves shall be opened for about 20 minutes.

5.3.15 Reduce pressure in liquid helium storage dewar to 5 psi.

5.4 1.9 K Pumping for Cable Test Dewar #5

NOTE: At present, the 1.9 K return line is DISCONNECTED. The 1.9 K line must be RECONNECTED before the following procedure can be exercised.

5.4.1 Fill up liquid helium in Dewar 5.

5.4.2 On the top plate of Dewar 5, drop the lambda separator plug into close position.

5.4.3 Go to the Trench next to Dewar 5, open the valve connected the discharge line of the 1.9 K pump to the dirty gas recovery bag.

5.4.4 Go to the 1.9 K pump room to turn on electrical power. Bleed water and oil out of the air supply header.

5.4.5 The interface control panel for the 1.9 K pump, located near Dewar 5, should read “Ready to Start”.

5.4.6 Push F2 on the control panel to start the 1.9 K pump. The initial setting, from the control, is 200 mm mercury.

5.4.7 Press F6 to initiate control. Use arrow to change set point. (Press F6 and arrow simultaneously allow fast change of set point). Watch pressure in the 1.9 K suction line, PI363. PI363 reads about 10 mm when the controller is set at 20 mm.

5.4.8 Watch temperature readings from the computer. Observe the rate at which temperature decreases. Typically the temperature decreases at 0.015 degree Kelvin per minute or approximately 1 K per hour.

NOTE: Normally, it takes three to four hours for the lower chamber to reach 1.9 K.

5.4.9 To shut down the 1.9 K pump, use F6 and arrow key on the control panel to increase the set pressure to 200 mm. Wait the return line pressure to reach 200 mm. Press F1 to shut down the 1.9 K pump.

5.4.10 Go to the 1.9 K pump room. Turn off the electrical power.

5.4.11 Open the lambda chamber separator plug from the top plat of Dewar 5.

5.4.12 Go to the Trench. Close the valve in the discharge line of the 1.9 K pump to the dirty gas bag.

5.5 Warmup for Cable Test Dewar #5

5.5.1 For warmup after a 4.5 K test, proceed to step 2. For warmup after a 1.9 K test, make sure the plug between the upper and lower chamber is open.

5.5.2 Make sure valves in the supply header

MOV300S - liquid helium supply,
MOV304S – warmup supply,
MOV305S – transfer line cooldown valve, and
MOV308S – 100 K cooldown supply, and
MOV310S – 1.9 K heat exchanger vent
are closed.

5.5.3 Make sure valves in the return header

MOV303S – to dirty gas bag,
MOV302S – to subcool return, and
MOV307S – to vacuum pump
are closed.

5.5.4 Set AOV301S, on low pressure return, to 18 psi and AUTO.

5.5.5 Slowly open warmup valve MOV304S. The upstream valve MOV306S is preset for normal warmup flow rate. Excessive opening of MOV306S may over pressurize the dewar. If adjustment of MOV306S is required, it must be performed with great care.

5.5.5.1 When setting the warmup flow, you can use the MOORE CONTROLLER for valve AOV301S, to help your adjustment on MOV306S

5.5.6 Watch the display page on the computer for Cable Tests. Liquid helium will boil off rapidly. Make sure the boil-off does not upset the compressor system for the refrigerators.

5.5.7 After liquid helium boiled off, turn on the electric heater. The temperature at the exit of the heater should be about 40 C.

5.5.7.1 Open valve MOV302S.

5.5.8 Watch temperature on the computer for Cable Tests. The temperature increases with time. It takes about 12 hours for the Dewar to reach room temperature.

5.5.9 Turn off electrical power to the warmup heater.

5.5.10 Close warmup supply valve MOV304S.

5.5.11 The purpose of warmup is to remove the cable sample. Therefore all supply and return valves must be closed.

5.5.12 Close MOV302S and AOV301S.

5.5.13 Make sure all supply valves and return valves are closed. Vent residual helium from the dewar.

5.5.14 The Cable Sample in Dewar 5 is ready for removal.

6.0 Documentation

6.1 A logbook, in spread sheet form, shall be maintained by the operator and kept on the PC located in 902 Cryogenic Control Room.

7.0 References

7.1 BNL Drawing, P&I D 902A, Cable Test Dewars, RD 12155434.

7.2 BNL Drawing, P&I D 902A, Liquid Helium Storage Area, RD 12155451.

8.0 Attachments

None